

RED WOLF MANAGEMENT SERIES

TECHNICAL REPORT NO. 3

A HISTORIC PERSPECTIVE OF CANIS RUFUS
AND ITS RECOVERY POTENTIAL



U.S. FISH AND WILDLIFE SERVICE
SOUTHEAST REGION
ATLANTA, GEORGIA



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A HISTORIC PERSPECTIVE OF CANIS RUFUS
AND ITS RECOVERY POTENTIAL

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Red Wolf Technical Report No. 3

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and its Recovery Potential

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I. Introduction

The long range objective of the Red Wolf Recovery Program has always been to reintroduce this extinct-in-the-wild species into portions of its historic range. The red wolf has been characterized by several writers as the "Flying Dutchman" of the wildlife world--a species that has sought a safe haven since the mid 1970s. This report has been prepared in an effort to bring forward the latest information available on the historical status of the species, the various factors that led to its ultimate demise in the wild, and the efforts being made to recover this unique animal in portions of its historic range.

II. Historic Overview

The Genus Canis in North America

At this time the most authoritative treatise on the origins of wild North American canids is found in Nowak's (1979) North American Quaternary Canis. Nowak has concluded that the genus Canis arose in the New World by the middle Pliocene. He has postulated that at some early point in time, an element of the primitive stock of small wolves in the New World entered Eurasia where they eventually gave rise to what we now know as the gray wolf (Canis lupus). During this time, other primitive canines in the New World evolved independently into forms that we now recognize as the coyote (C. latrans) and the red wolf (C. rufus). It appears that at some point after the long periods of glaciation, the gray wolf then invaded North America from Asia. Thus, the red wolf is a much older form of Canis and the only North American wolf to have evolved entirely in the New World.

Although it was historically a western canine, with man's help, the coyote has rapidly expanded its range in the last century. Today it is found throughout North America. The domestic dog (C. familiaris) was introduced by man to North America and is the most numerous species found in the genus Canis. Although an occasional dog is observed in the wild, the species has not become an established wild form in North America. Dogs have been known to hybridize with wolves and coyotes.

Wolf populations around the world have been effectively reduced by man's activities. The gray wolf has been extirpated from much of its historic range, and by 1970 the red wolf was reduced to a remnant species. In 1980 the U.S. Fish and Wildlife Service determined the red wolf to be extinct in the wild. Since then, the species has existed only in captivity.

Range of the Red Wolf

Early explorers of the Southern United States often encountered wolves, but the first to describe the red wolf was Bartram (1791), who collected a type specimen in Florida. Audubon and Bachman (1851) described a uniquely red Texan wolf and also a black American wolf which frequented the western portions of Kentucky. Young (1944) determined that the red wolf is a distinctly American species with a restricted range, while Paradiso and Nowak (1971), in reviewing the taxonomic status of the red wolf, concluded that this

wolf is essentially a "warmth-adapted" species in contrast to the more cold-adapted gray wolf.

By the early 1970s, red wolves were found only in Louisiana and Texas. Of the three subspecies that may have existed, only C. rufus gregoryi survives today. This subspecies originally ranged from east Texas to the State of Mississippi. It probably occurred throughout Arkansas, Missouri, southern Illinois, Kentucky, and Indiana. The eastern subspecies of the red wolf, C. r. floridanus, is thought to have become extinct during the early 1900s (Carley 1975). It appears that this subspecies existed during colonial days along the Atlantic seaboard from southern Delaware and Pennsylvania to Florida and westward through Alabama, central Tennessee, and eastern Kentucky. The third subspecies, C. r. rufus, was found only from central Texas to east Texas and became extinct in the late 1960s (Carley 1975).

Relationship with other Canis

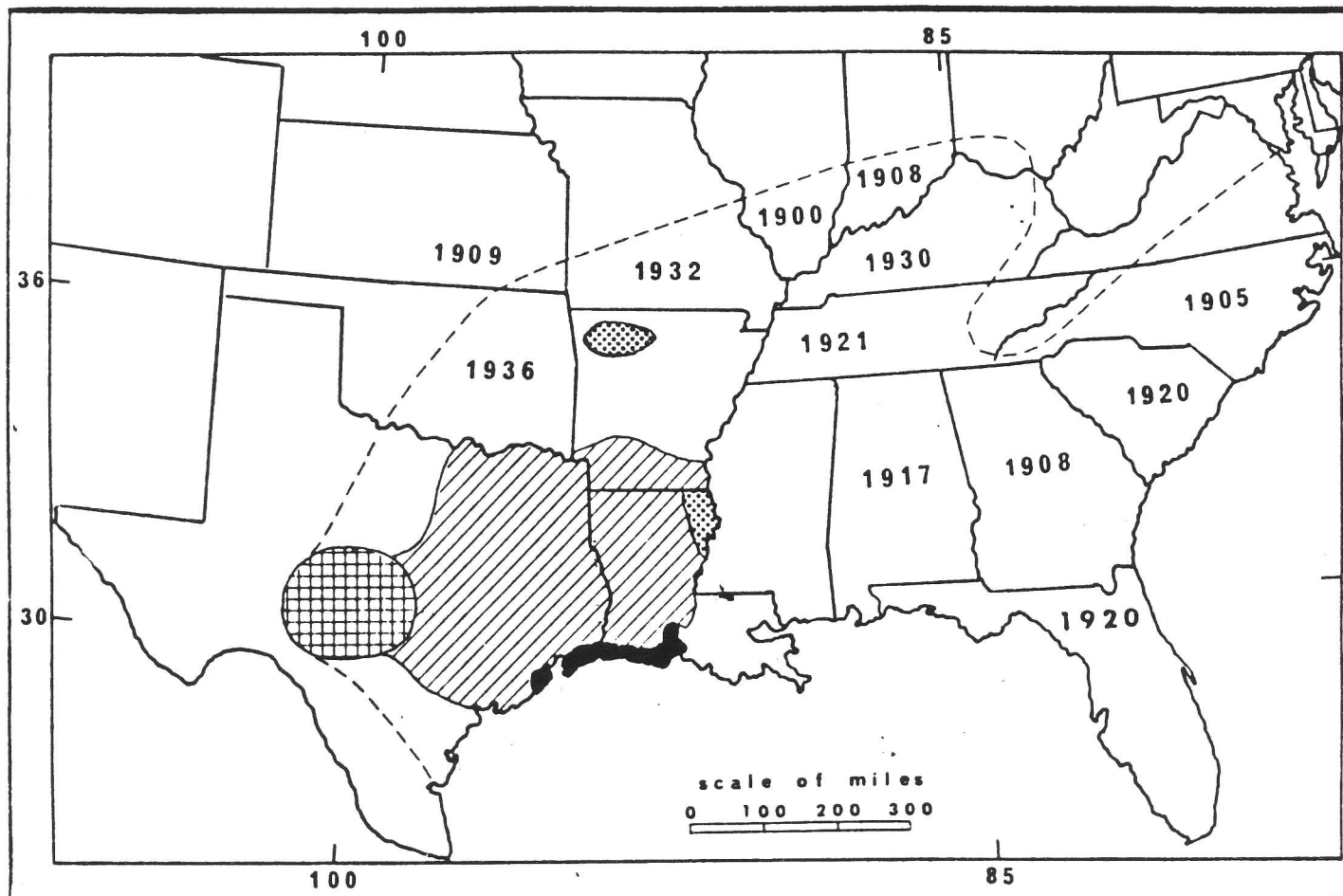
In summarizing the historical evidence of the many circumstances that led to the demise of the red wolf, it is imperative that treatment be provided the original conditions that maintained the species. As pointed out by Paradiso and Nowak (1971), the coyote and red wolf are allopatric species. Their range met along a line that ran through central Texas and Oklahoma, with C. latrans co-inhabiting the drier western regions and grasslands with subspecies of the gray wolf. Canis rufus, however, was found primarily in the southeastern forests, swamps, coastal marshes, and prairies. Due to differences in social structure, it appears that these two species maintained themselves with little interbreeding as late as the 1900s.

A much more illusive problem concerns the historical relationship of C. lupus with C. rufus in the eastern United States. How and precisely where their range met and/or overlapped will probably always be subject to debate. Over time, this range boundary likely moved back and forth as much as several hundred miles as climatic and other conditions changed. A critical examination of fossil records and recent archeological deposits by Nowak (1979) demonstrate a generalized range for C. rufus south and east of a line from southern Pennsylvania through southern Ohio, southern Illinois and Indiana, central Missouri, and eastern Oklahoma and Texas (see map No. 1). Nowak's work also identified fossil C. lupus finds in western Virginia and extreme northwestern Georgia. These finds indicate some potential for the overlap of C. rufus and C. lupus along the higher elevations of the southern Appalachian Mountains. A discussion in 1979 with Dr. Fredrick S. Barkalow, Jr. (personal communication) at North Carolina State University revealed a probable red wolf find dating from about 1700 A.D. in Macon County, North Carolina. This right maxillary fragment was also examined by Dr. Ronald Nowak who determined the specimen to be probably C. rufus (personal communication).

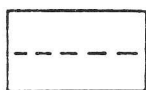
It should be stressed that in many range maps, most notable of which was Hall and Kelson (1959), the red wolf was depicted as being historically excluded from South and North Carolina, Virginia, and all but the extreme western portions of Kentucky and Tennessee. The revisionary work of Nowak (1979) has placed the historical range of this species in a much clearer perspective.

Map No. 1
Red Wolf Range Map

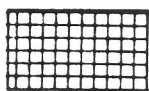
Dates on map refer to last records of wolves in states indicated



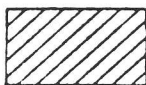
Canids in the Southeastern United States



Estimated limits of original range of the red wolf (*Canis rufus*). The gray wolf (*C. lupus*) existed primarily to the north and west of the red wolf. The coyote (*C. latrans*) was found in western North America.



Area where hybridization between the red wolf and coyote apparently began, as shown by specimens 1899-1918.



Area in which hybrid canids have been collected since 1960.



Current range of the red wolf, as shown by specimens and field work.



Areas in which the presence of wolves has been indicated by howling searches.

Human Conflicts

When the first American settlers arrived in what is now the southern Atlantic States, they typically brought with them deeply-rooted European fear and hatred for wolves. Many of these Old World attitudes were founded on an animal that apparently was more aggressive than its North American counterpart. Whether more aggressive or not, these Old World fears centered on the wolf as being not only a menace to farm and flock, but also in concert with the Devil. Satan's servants changed from human form to wolf form as werewolves (Oakley 1986).

With these ingrained fears, it is little wonder that New World wolves were pursued with vengeance, and indeed, by 1920 C. r. floridanus was extirpated in the South Atlantic States. The species, by this time, had also vanished from southeastern Kansas and central Oklahoma and from much of its former range in Texas. By the late 1930s it is thought that there existed only two viable concentrations of red wolves. One of these was located in the Ozark-Ouachita Mountain region of Arkansas, eastern Oklahoma, and southern Missouri, and the other was in the still extensive river bottom forests and coastal regions of Louisiana and southeast Texas (Nowak 1972).

III. The Demise of a Species

Man played the major role in the extirpation of the eastern subspecies of red wolf, C. r. floridanus. As mentioned earlier, fear and a gross misunderstanding of the animal led to early bounties and indiscriminate killing of wolves. Secondary impacts by man included extensive land clearing and drainage projects during the early 1900s. The advent of World War I, with resultant logging and mineral exploration and road development, opened up last vestiges of once remote habitat and probably was the final blow that eliminated C. r. floridanus. These activities had similar impacts on other large predators, including the Florida panther (Felis concolor coryi).

These conditions paralleled the decline of deer herds and other forest wildlife which could have affected red wolf populations as prey species. It is probably no coincidence that deer herds in the Southeast reached their all-time low point in population around 1920 (Barick 1951), a date that approximates the demise of C. r. floridanus. With deer at all-time lows, wolves were probably forced into closer contact with man and agricultural lands which typically harbored small prey species such as rabbits. Livestock undoubtedly attracted some wolves with resulting wolf-related losses. All of these factors contributed to intensified predator control efforts.

Beginning around 1920, enough forest habitat had been cutover in eastern Texas and Oklahoma to intensify an eastward surge by C. latrans. This adaptable species responded for reasons that go beyond changes in land use. As mentioned earlier, for thousands of years it appears that C. latrans and C. rufus existed along a north-south line that roughly divided Texas and Oklahoma. As predator control efforts became more efficient, the larger and more easily caught red wolf (Pimlott, et al. 1968) was totally removed from extensive areas while in other areas its social structure was destroyed. Into

these vacated niches flowed C. latrans. Over the years the situation became more and more threatening for the red wolf. The possibility that the species was actually in danger of becoming extinct was first voiced by McCarley (1962).

Paradiso and Nowak (1971), in reviewing the circumstances that led to the decline of C. r. rufus and C. r. gregoryi, point out that red wolf museum specimens collected west of the Mississippi River after the 1930s were much smaller than those collected prior to the 1930s. These they describe as a "different kind of canid." This situation was especially prevalent in northeast Texas, southern Louisiana, and portions of Arkansas where significant morphological diversity of representative canids indicated hybridization between red wolves and coyotes. This did not appear to be true in Oklahoma and Missouri where C. latrans simply replaced C. rufus as a result of effective control efforts.

By 1972, the range of the red wolf had been eroded down to a small coastal unit that included parts of Liberty, Chambers, Jefferson, Brazoria, Galveston and Harris Counties in southeastern Texas, and Cameron and Calcasieu Parishes in southwestern Louisiana (Riley and McBride 1972). Here the red wolf continued to be threatened by man, and an ever expanding coyote population that threatened to overwhelm the species unless dramatic actions were taken by the Service.

IV. The Recovery Program

In anticipation of the passage of the Endangered Species Act, the U.S. Fish and Wildlife Service established a formal recovery program for the red wolf in the fall of 1973. Responsibility for the program was assigned to the Texas State Office of the Service's Division of Animal Damage Control in San Antonio, Texas. Mr. Curtis J. Carley was selected to be the program Project Leader. A Red Wolf Recovery Program office was established in Beaumont, Texas, near the heart of the remaining range of the species. With the field program for the red wolf already underway, the Endangered Species Act was passed on December 28, 1973.

The recovery program was established on the basis of information indicating that a pure population of red wolves still existed in southeast Texas and adjacent areas of Louisiana. However, early field work soon discovered that the "hybrid swarm" had already invaded the last area of the red wolf's historic range. Among the canines of the area, wolves appeared to be in the minority. This finding completely redirected the recovery program from an objective of local preservation to one of planned extinction of the species in the wild. The decision to remove the last red wolves from the wild could only be justified through the development of a long-range objective to eventually return the species to areas of its historic range.

The early Red Wolf Recovery Program was multifaceted. Since approximately 98 percent of the final range of the species was in private ownership, the first priority of the program was to respond immediately to any and all canine damage complaints. This action gave the program access to canine populations

on private lands, reduced human persecution of the species, and gained landowner cooperation. While responding to damage complaints, the program had to simultaneously develop methods for determining "pure" wolves and wolf-like hybrids, establish a captive breeding/certification program, monitor and evaluate alleged red wolves already in the Nation's zoos, develop and disperse public information, and evaluate sites and procedures for reestablishment of the species in the wild.

Having solicited proposals from several zoo facilities, a captive breeding/certification program was established on November 26, 1973, through a cooperative agreement between the U.S. Fish and Wildlife Service and the Metropolitan Park Board of Tacoma, Washington. The program was to be administered by the Board's Point Defiance Zoological Park under the direction of Mr. Norman R. Winnick. Coordination of the effort was administered by the Beaumont, Texas, field office of the recovery program.

Pending development of procedures for appointing endangered species recovery teams under the new Endangered Species Act of 1973, the Southwest Regional Office of the U.S. Fish and Wildlife Service established an Interim Red Wolf Recovery Team on August 4, 1974. Since a biological staff was already working with the species, the purpose of the team was to advise and administratively assist the program in accomplishing its objectives. Team members were carefully selected not so much for their biological knowledge, but for their knowledge of state and Federal agency processes, procedures, and resources. Mr. Russel W. Clapper, Manager of the FWS Anahuac National Wildlife Refuge, was selected as the Team Leader. Serving with Mr. Clapper were Mr. George R. Abraham (FWS), Mr. Joe Herring (Louisiana Department of Wildlife and Fisheries), and Mr. Floyd Potter (Texas Parks and Wildlife Department). A number of consultants were officially designated to advise the recovery team and arrangements were made for the team to confer with anyone who might have special knowledge that would be helpful in developing recommendations. The Interim Recovery Team held its first working meeting in October 1974. The interim team was subsequently officially appointed in January 1975.

Due to the urgency of implementing recovery of the species, contracted studies were limited to those that would contribute directly to the objective of recovery. Proposed research projects were carefully evaluated for their potential of providing immediate information that would significantly aid the program in meeting its objectives. During the course of the program, only four projects were approved as having immediate benefit to the species. These projects related to sonographic analysis of canine vocalizations as an aid in locating and censusing canines in the wild; electrophoretic and chromosomal analysis of canines to aid in identification of red wolves and wolf-like hybrids; development of techniques for x-raying skulls of live canines to compare them to skulls of known wolves from museum collections; and an evaluation of internal and external parasites found in the canine population of the red wolf range. All canines obtained by the field program were carefully examined and evaluated. Complete records were obtained for each animal. In addition to attempting to recover the red wolf, the program was now also documenting the demise of a species through hybridization in the wild. Due to the confusion of characteristics displayed by the hybrid infested population, no one character could be used to identify true wolves.

It was possible for even the most wolf-appearing animal to simply be a wolf-like hybrid. Therefore, a number of "indicators" were used to determine the probability that an animal was a wolf. The indicators used included gross taxonomic measurements, skull x-rays, electrophoretic and vocalization analysis, and knowledge of other canines examined from the same area as the animal in question.

Canines determined to be possible wolves were placed in the breeding/certification program, or if all facilities were full, they were released with radio collars on public lands or where private land-owners gave permission. Since releasing captured coyotes and/or hybrids would tend to alienate private landowners and would increase the work load of the recovery effort due to unavoidable recaptures of animals, all canines determined to not be wolves were humanely euthanized, and their skeletal remains and data cards were preserved as documentation of the canine population that was examined by the program. When the field program was concluded, all acquired specimens and data were transferred to the U.S. National Museum, Washington, D.C. for continued preservation.

From the fall of 1973 to July 1980, over 400 wild canids were examined by the recovery program. Of that number, only 40 animals were admitted to the breeding/certification program as probable red wolves. Due to the complexities of hybridization, final "proof" of the genetic integrity of the animals could be determined only through the captive breeding process itself. Offspring born to the program were maintained for 1 year and examined quarterly for the purpose of confirming the initial identification of their parents. A number of early litters were determined to be hybrids. Hybrid offspring and the suspected hybrid parents were thus systematically removed from the program. In some cases the parents of hybrid litters had to be bred with other wolves to produce a second litter that would determine which of the parents of the original litter was the wolf-like hybrid. Although more of the original 40 wild canids in the program may have been true red wolves, short life spans, limited breeding facilities, and unavoidable medical problems such as an outbreak of Parvo Virus resulted in only 17 of the animals becoming the founding stock of the red wolves existing today. The remains of all canines in the breeding/certification program, including those captively produced, were saved for preservation at the University of Puget Sound, Tacoma, Washington.

In the fall of 1984 the red wolf captive breeding program was accepted by the American Association of Zoological Parks and Aquariums (AAZPA) for development of a Species Survival Plan (SSP). This ensured the integrity of all red wolf captive breeding efforts and greatly enhanced the Service's responsibility to properly carry out a selective breeding program for the species. The main thrust of this cooperative effort is to ensure the genetic integrity of the red wolf under captive conditions.

The red wolf captive breeding program has evolved into the most successful endangered species captive effort in the United States. The Point Defiance Zoo continues to administer the program through an annual contract with the Fish and Wildlife Service. Under the leadership of Mr. Roland Smith, the zoo won the prestigious Edward H. Bean award in 1987 for its leadership in long-

term red wolf captive breeding. In addition to the contract facility administered by the Point Defiance Zoo, there are six other zoos in the United States that are participating in the red wolf recovery program. These are the Audubon Park Zoo, New Orleans, Louisiana; the Alexandria Zoological Park, Alexandria, Louisiana; the Texas Zoo, Victoria, Texas; Burnet Park Zoo, Liverpool, New York; the Tallahassee Junior Museum, Tallahassee, Florida; and the Wild Canid Survival and Research Center, Wolf Sanctuary, Eureka, Missouri. At the time of this writing, there are 80 red wolves in existence; of these, eight are in the wild at Alligator River National Wildlife Refuge, and the remainder are in various captive facilities in the United States.

In 1978, due to increasing responsibilities at the Anahuac National Wildlife Refuge, Mr. Russel W. Clapper resigned his position as Team Leader of the Red Wolf Recovery Team. The administrative responsibility for the recovery team was then transferred from the Southwest Regional Office to the Southeast Regional Office in Atlanta, Georgia, and Mr. David W. Peterson (FWS) was appointed as the new Team Leader. Mr. Abraham and Mr. Herring remained on the recovery team; however, with the center of recovery actions moving to the southeast, the Texas Parks and Wildlife Department withdrew from formal participation on the team. Ms. Mary Anne Young, a member of the Audubon Society, was appointed as a new team member representing the concerns of environmental organizations. Mr. Warren T. Parker (FWS) was assigned the responsibility of helping locate a suitable mainland reintroduction site for the red wolf in the Southeast.

V. Early Reintroduction Efforts

With the species at least safeguarded in captivity, program emphasis shifted to a strategy of reintroduction. Due to a history of failure in previous attempts to reintroduce gray wolves in various areas, initial thoughts centered on locating an area where an experimental reintroduction could be employed to test management and public information techniques. It was only reasonable to look for such a temporary project in the southeastern United States within the historic range of the red wolf. Bulls Island, a 5,000-acre island component of the Cape Romain National Wildlife Refuge in South Carolina, was selected for such an experiment. A great deal of effort was expended in coordinating a project with local and state officials and securing necessary grassroots support. A 50-ft. x 50-ft. chain link acclimation pen was constructed on the island, and on November 3, 1976, a pair of wild-caught, adult red wolves was flown from Tacoma, Washington, to Charleston, South Carolina. They were carried by truck and boat to the refuge island and placed in their pen. On December 13, 1976, they were released. These two animals wandered extensively, leaving Bulls Island and going to nearby Dewees and Capers Islands. After 9 days of freedom, the female left Capers Island and was recaptured on the mainland. The male was recaptured within hours on Bulls Island.

Throughout this phase of the project, there was a very positive response from the local populace who were genuinely concerned for the welfare of these animals.

A second Bulls Island reintroduction experiment was begun with the arrival of another pair of wild-caught, adult red wolves in Charleston on July 5, 1977. This pair of animals was kept in the acclimation pen for 6 months. The wolves were fed island prey species during their longer acclimation, and released on January 5, 1978. The pair remained on Bulls Island and adjacent Capers Island for over 8 months and obviously adjusted to life on this South Atlantic coastal island complex. The decision to recapture them was consistent with the original objective of the experiment. Both animals were recaptured by use of a tranquilizer dart fired from a pursuing helicopter. It should be remembered that both of these releases onto Bulls Island were planned to be temporary, short-term projects to work out acclimation and release techniques. It was concluded that both releases were successes and yielded valuable information for future reintroduction attempts.

For the next 2 years, the Red Wolf Recovery Team evaluated various sites for a possible mainland reintroduction project. Sites included Everglades National Park, and Big Cypress Swamp, Florida, and Ossabaw Island, Georgia. During a red wolf recovery team meeting in June 1978 at Savannah, Georgia, a Tennessee Valley Authority (TVA) representative invited the team to examine the Authority's Land Between the Lakes (LBL) area in west Kentucky and Tennessee.

A field review of the LBL site was made by the Team during July 1979, and a formal recommendation to initiate a red wolf reintroduction effort was made to the Regional Director of the Fish and Wildlife Service (FWS) by letter dated September 7, 1979, signed by the Team Leader. A series of meetings to brief the Kentucky and Tennessee State Wildlife Management agencies were held and the Director of the Service, by letter of August 1, 1980, to TVA's Chairman of the Board of Directors, requested TVA to formally consider a red wolf reintroduction proposal at LBL. Over the next 3 years, a great deal of coordination and interagency work was accomplished. In July 1982 a Red Wolf Recovery Plan was approved by the Service. Also, a formal proposal to reintroduce red wolves at LBL was published in October 1983 (Carley and Mechler 1983). In June 1983 TVA and FWS representatives met with Kentucky and Tennessee Congressional delegations in Washington to review the LBL red wolf proposal.

On September 25 the TVA Board approved the project and on October 21, 1983, a formal news briefing was held at LBL which described the proposal to the media and to the public. During the next three weeks, a great deal of media attention focused on the proposed wolf project at LBL. Both FWS and TVA personnel presented mass media programs in an effort to inform the local public about the plight of the red wolf, the true nature of the animal, and the details of the reintroduction proposal. During the last week of November and the first 2 weeks of December 1983, three public meetings were held in Kentucky (Kentucky Lake State Park, Bowling Green, and Lexington), and four public meetings were held in Tennessee (Paris, Dover, Clarksville, and Nashville).

Public input was generally mixed in both states, but organized opposition from environmental, livestock, and hunting interests evolved into a major factor that politically doomed the proposal. Particularly outspoken opposition came from Stewart County, Tennessee, the only Tennessee County bordering LBL by

land, where nearly 100 percent of those attending the Dover public meeting opposed the project. Another major contributing factor was the reaction of hunters who feared that the presence of red wolves on LBL would result in injunctions and court actions by protectionist groups to stop hunting on the area. This view was reinforced by letters from Defenders of Wildlife and the Humane Society of the United States that voiced objections to the LBL reintroduction. These environmental groups expressed concern that reintroduced red wolves would not have complete protection of the Endangered Species Act.

Based on these and other relevant points of contention, the Tennessee Wildlife Resources Agency unanimously rejected the LBL red wolf proposal at a public meeting on January 6, 1984. Shortly thereafter, the Kentucky Department of Fish and Wildlife Resources adopted a similar statement of opposition. The Service withdrew the proposal in view of these events.

In retrospect the LBL proposal was certainly well thought out and carefully conceived. It now appears, however, that not enough time was allocated to working with local officials and the public. More time should have been directed to those interests that later surfaced in organized opposition to the reintroduction of any predator. The spread of the coyote into the LBL area during the early 1980s also complicated the process and raised serious biological questions about potential interbreeding. Also, administrative and decision-making processes involved in dealing with four distinct agencies (TVA, FWS, and the wildlife agencies of Kentucky and Tennessee) made quick resolution of any problem more difficult.

A great deal was learned from the LBL project, and these hard-taught lessons were soon to be applied in eastern North Carolina.

VI. Reintroduction at Alligator River National Wildlife Refuge, North Carolina; Island Propagation Strategy.

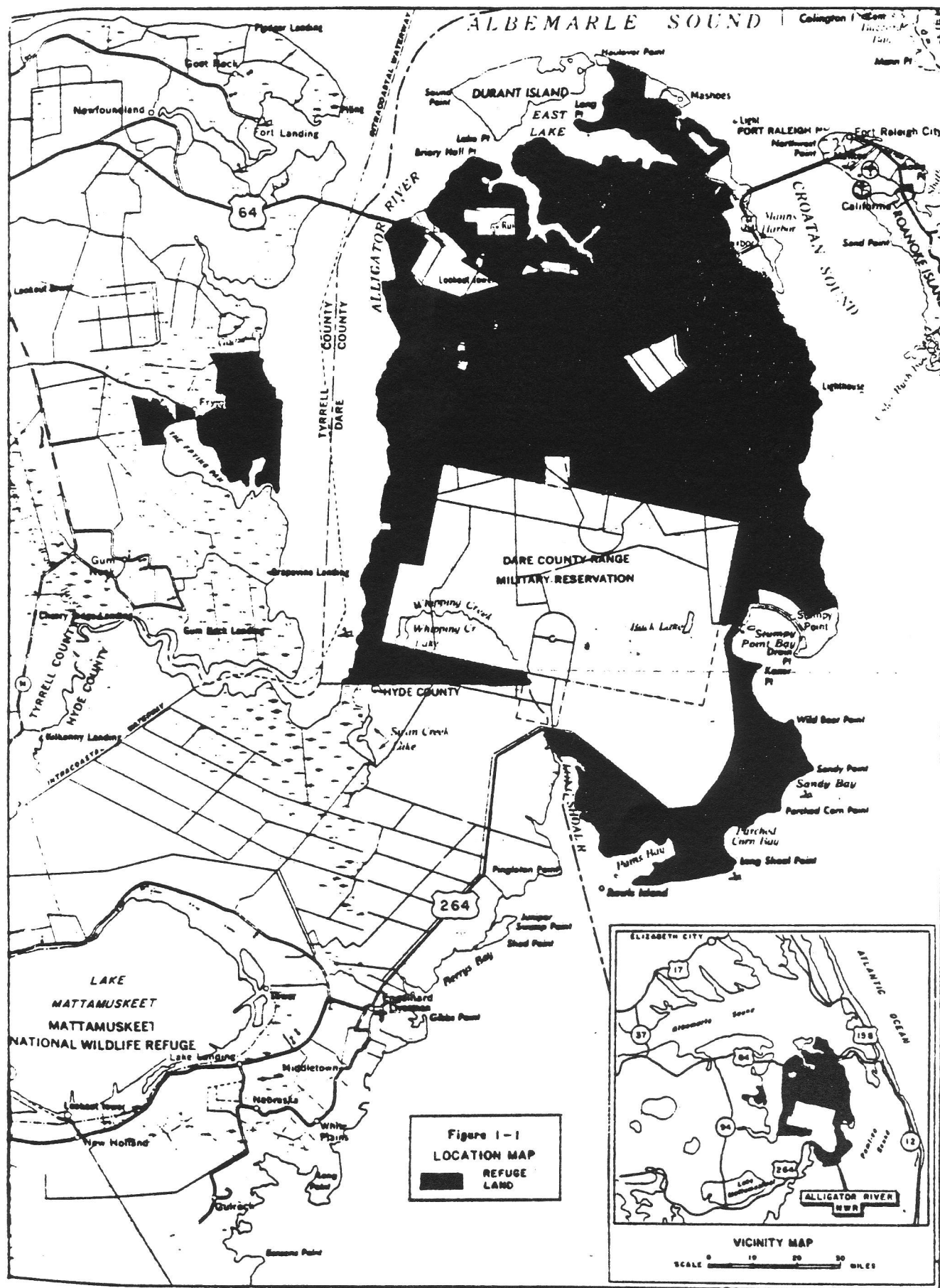
In March 1984 the Prudential Insurance Company donated nearly 120,000 acres of freshwater riverine swamp, pocosin, and brackish marsh habitat to the FWS in Dare and Tyrrell Counties, North Carolina. These lands were later to become the Alligator River National Wildlife Refuge. Field studies conducted by the North Carolina Biological Survey (NCBS) (Potter 1982) and later work jointly done by NCBS and FWS personnel indicated that the refuge harbored a moderate to good prey base for red wolves. In addition, intensive surveys indicated a total absence of coyotes and feral dogs. There is no livestock in the county, and the mainland portion of the county (see map No. 2) is sparsely populated.

After prey surveys were completed, a great deal of time was devoted to developing a favorable public climate for such a project. Initial efforts were directed at major environmental organizations, and a meeting held in Washington, D.C., was an effort to solicit the help of these groups. Soon afterward, a detailed reintroduction proposal was developed (Parker 1987a). The North Carolina Congressional delegation was thoroughly briefed on the proposal, as was the North Carolina Wildlife Resources Commission, the Commissioner of Agriculture, and the Governor's staff. In concert with

ALLIGATOR RIVER NATIONAL WILDLIFE REFUGE

DARE AND TYRRELL COUNTIES, NORTH CAROLINA

UNITED STATES
FISH AND WILDLIFE SERVICE



COMPILED IN THE DIVISION OF REALTY
FROM SURVEYS BY U.S.G.S.

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these contacts, the Dare County Commissioners were briefed. Numerous personal contacts were made with local citizens, especially prominent hunters and trappers. The new refuge manager, Mr. John Taylor, provided great assistance in working with the citizens of Dare County.

Dare County residents are deeply rooted in outdoor pursuits. Many continue to earn part or all of their income from commercial fishing and shellfishing. Hunting, fishing, and trapping are the norm for many of these residents. Some viewed with great suspicion the Federal Government acquiring essentially the major portion of their county. A series of four public meetings held in February 1986, however, clearly demonstrated that as long as traditional usages of the new refuge were not significantly altered, the local public would support a red wolf reintroduction effort. Based on this information, the Regional Director of the Southeast region of the Fish and Wildlife Service, in consultation with the Director of the North Carolina Wildlife Resources Commission, determined that the project was feasible. Field work was completed, pens were constructed, and a special regulation designating red wolves reintroduced at Alligator River National Wildlife Refuge as experimental and nonessential was promulgated and published in the Federal Register on November 19, 1986 (Fed. Reg. 51:41790-41796). Four pairs of adult red wolves were shipped from Tacoma, Washington, to the refuge on November 12, 1986.

A new Red Wolf Recovery Team was appointed. Membership included Roland Smith, Assistant Director of the Point Defiance Zoo, Tacoma, Washington; Bill Malloy, Administrative Director of the Wild Canid Survival and Research Center, Eureka, Missouri; Dr. Michael Pelton, University of Tennessee, Knoxville, Tennessee; Don Wood, Florida Game and Freshwater Fish Commission, Tallahassee, Florida; Curtis Carley, FWS, Albuquerque, New Mexico; and Warren Parker, Team Leader, U.S. Fish and Wildlife Service, Asheville, North Carolina. Dr. L. David Mech, U.S. Fish and Wildlife Service, St. Paul, Minnesota, serves as team technical advisor, and Ms. Mary Anne Young, U.S. Fish and Wildlife Service, Atlanta, Georgia, serves as Regional Office team advisor. Mr. Malloy and Mr. Carley resigned soon after their appointment. Dr. Victor Nettles, School of Veterinary Medicine, University of Georgia, replaced Mr. Malloy. Team membership was completed with the appointment of Dr. U.S. Seal, Veterans Administration Hospital, St. Paul, Minnesota. The first team meeting was held at the refuge on December 2 and 3, 1987.

A primary facet in developing the Alligator River Refuge project was the use of a special tracking collar that also had the capability of injecting an immobilizing drug upon radio command (Mech, et al. 1984). The delivery of these collars was expected in May 1987. Because of unexpected delays in development of the 3-M Corporation "capture collar," wolves were not released until September 1987, a major deviation from the proposed spring 1987 release. These eight animals adjusted well to their new environment. Two females died during December 1987. On January 22, 1988, three additional pairs of wolves were shipped to the refuge, as previously planned, along with two replacement females. These replacement females were paired with the two originally released males after the males were recaptured. These two pairs were released back into the refuge on April 12 and 14, 1988, after an 80 and 82-day acclimation period.

A strategy to propagate wild red wolf offspring was initiated on November 19, 1987, when a pair of adult wolves was shipped from the captive breeding project in Washington state to Cape Romain National Wildlife Refuge, South Carolina. These animals were placed in an acclimation pen on Bulls Island and were allowed to breed. On April 22, 1988, four pups were born, three of which survived. It is hoped that these pups will adjust to the wild. If all goes as planned, the young will be captured at about 10 months of age and utilized as wild animals in either a reintroduction effort or in the captive breeding project (Parker 1987b).

VII. Recovery Potentials and Management Strategies

During the trapping program of the early 1970s, project personnel were impressed with the tenacious ability of red wolves to survive. Unfortunately, the wild founding stock that formed the origins of the red wolf captive breeding program have now essentially passed from the scene (only 2 of the 17 founders survive to this date). As anticipated, preliminary experiences gained at Alligator River Refuge indicate that F_2 and F_3 captive offspring can adjust and maintain themselves in the wild if provided the opportunity.

It should be noted that practically all of the information published on the species is based on studies conducted in the coastal prairie and marshes of Louisiana and Texas. Since these habitats are considered to be marginal red wolf range, it is with great interest that we can now observe this unique animal in what is thought to be better range.

The Indian belief that people and wolves can coexist in harmony has only recently begun to be accepted by the rest of the American public (Nee and Oakley 1986). In modern America, the degree to which wolves can exist in the presence of humans is dependent on the attitudes of people living within and adjacent to a wolf reintroduction site. Potential release sites should not be excluded from consideration because of human presence, unless that presence poses a direct threat to the survival of the reintroduced wolves.

Based on experiences gained with red wolf reintroduction attempts, it appears that the longer wolves have been absent from a locality, the better the chances are of gaining public acceptance of a project. This may be due to a lack of preconceived ideas regarding wolves and their potential for disrupting human lives and activities. Preconceived fears and concerns of predatory wildlife are generally rooted in a lack of understanding and also in tradition. A better educated public is a more receptive public, and this underscores the necessity of working closely with the local populace when a possible wolf reintroduction site is identified.

With public support, a wolf reintroduction can succeed anywhere there is sufficient range and an abundance of prey species. Realistically, however, there are few areas within the historic range of the red wolf where major mainland reintroductions can be contemplated. Therefore, these remaining areas must be examined carefully and well thought out strategies must be tailored to fit a specific site.

Probably the biggest factor weighing against the red wolf recovery effort is the public notion that the species cannot survive in any association with coyotes. This conclusion is based on poorly understood factors that surrounded the "hybrid swarm" that swept across what was left of red wolf range in the 1970s (Carley and Mechler 1983). Simply put, when red wolf numbers in Louisiana and Texas were at extreme lows, it became difficult, and in some cases impossible, for a lone red wolf to locate a mate. Under these unusual circumstances, interbreeding with coyotes took place, and indeed the red wolf as a species came dangerously close to losing its identity. Speciation, however, is a most powerful force in nature. Red wolves and coyotes existed for thousands of years in central Texas and Oklahoma in allopatric harmony. Man's intervention ultimately created a set of circumstances that simultaneously devastated red wolf habitat and populations. This alteration of a naturally occurring system permitted the more adaptable coyote to fill vacant, altered habitats. When man's attention finally turned to the plight of the red wolf, there was only a relict population to examine. We can now surmise that this population had been tempered by a host of biological as well as environmental factors.

In examining canid literature, it becomes obvious that there is a hierarchy among the various species. A recent investigation by Sargeant et al. (1987), demonstrates spatial relationships between coyotes and red foxes in North Dakota. This study concluded that a red fox population would gradually decline as the coyote population increased. Other investigators have drawn the same conclusions regarding coyote-gray wolf range overlaps (Carbyn 1982, Mech 1970). Of special note are studies reported on by Berg and Chesness (1978) and Fuller and Keith (1981) who concluded that coyotes avoid wolf territories.

Since there are few large areas left within the historic range of the red wolf that are suitable for reintroduction purposes, it is of great importance that these areas be critically examined as soon as practical. This is frustrated, however, with the sure knowledge that at least 80 percent of this historic range is now occupied by coyotes. Therefore, it is imperative that carefully designed projects be developed and executed that would actually measure impacts of red wolves introduced into areas with resident populations of coyotes. If red wolves can indeed mimic gray wolves in competition with coyotes on good range, and thus develop a sympatric or allopatric relationship with resident coyotes, then long-term recovery objectives for the species would become much more attainable.

In the interim, special red wolf propagation projects on small controlled island components of the National Wildlife Refuge system and National Park system lands are of special interest. Young wild wolves born on these islands would be utilized in possible reintroduction efforts and in various captive breeding projects. Yet even with these small island projects and one or two major mainland projects, the genetic vigor of the species is going to have to be heavily augmented with various captive breeding projects throughout the United States. This reality is best expressed in numbers of red wolves that can be placed and managed in the wild. This figure would likely never exceed 300 animals. To maintain genetic variation and retard genetic drift within the species, it is likely that 200 to 250 red wolves will have to be

continually maintained in captivity. These figures were derived from demographic and genetic studies conducted for the Species Survival Plan (SSP) by Dr. Tom Foose and Dr. U.S. Seal (personal communication). An interchange of animals to and from the wild to and from captivity would also be necessary.

Long-term management must include the capture or possible destruction of errant red wolves. As already evidenced with the Alligator River Refuge project, wolves can be lost in recapture efforts. Beyond this ever present potential, a successful red wolf recovery program must one day come to grips with population reduction at various times. This will happen as an established population breeds, dispersing young that will try to colonize areas beyond the boundaries set aside for the wolf project (Mech 1979).

Management strategies should continue to focus on long-term recovery objectives, while building daily on a base of biological experience being gained at reintroduction, propagation, and captive breeding projects. Nee and Oakley (1986) correctly identify the issue, however, when they state that wolf management is a public issue, and "public education about wolves may have more to do with their survival than all the recovery plans in the world. Biologists are betting that the more we know about wolves, the more we will want to protect them and ensure their survival."

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